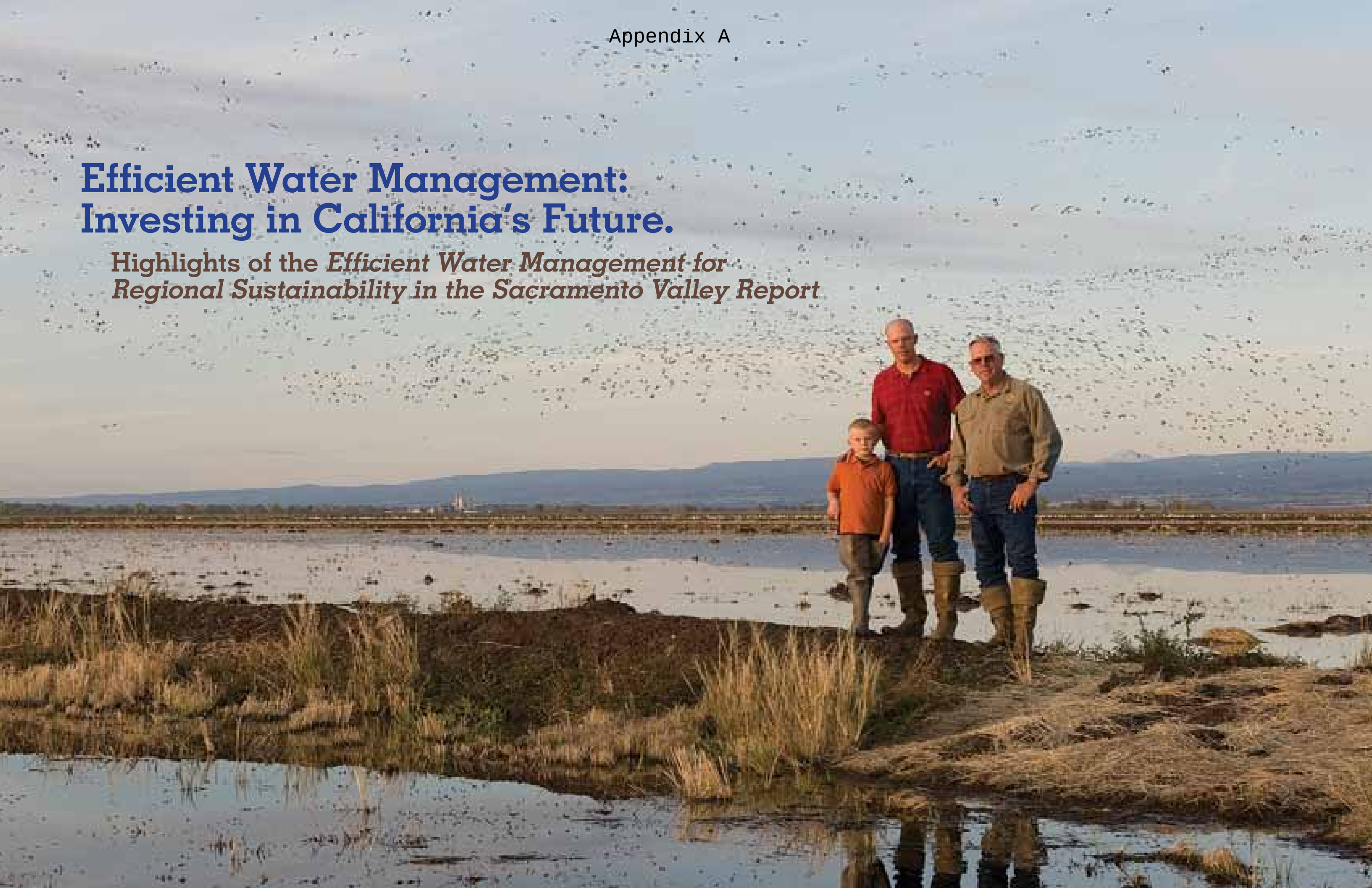
Appendix A

Efficient Water Management: Investing in California's Future.

Highlights of the *Efficient Water Management for Regional Sustainability in the Sacramento Valley Report*



Over 2.2 million people call the Sacramento Valley home.

Essential. Efficient. Exceptional.

The Sacramento Valley is essential to the long-term health and viability of the state of California and its citizens.

The Sacramento Valley is an exceptional place to live, work and raise a family. Equally important, the Valley is an essential part of California's economic well-being and long-term viability. Preserving the Sacramento Valley requires that we continue to use our water resources efficiently and wisely.

Water in the Sacramento Valley is the lifeline for:

- Highly productive farming that supports the region's economy and communities,
- Healthy ecosystems that support a host of critical plant and animal species,
- Recreational opportunities for people within and outside the Valley.

To ensure that the Valley's water resources continue to be sustainably and efficiently managed, the Northern California Water Association (NCWA) commissioned a report on *Efficient Water Management for Regional Sustainability in the Sacramento Valley*.

This document – *Efficient Water Management – Investing in California's Future* – presents an overview of the report's findings. The entire report can be found at the NCWA website – **www.norcalwater.org**.

The unimpaired flow from the Sacramento River hydrologic region averages approximately 22 million acre-feet annually, nearly one-third of the state's total annual runoff and the largest contributor of inflow to the Bay-Delta.

Limited Resources, Increasing Demand.

California policy requires that "each region that depends on water from the Delta watershed shall improve its regional self-reliance for water through investment in water use efficiency, water recycling, advanced water technologies, local and regional water supply projects, and improved regional coordination of local and regional water supply efforts." (Water Code §85021.)

To meet this objective, the allocation and management of water resources – whether it's from surface water, reused water, groundwater or for refuge and habitat management – will require careful consideration if we are to ensure that water resources are managed to support our long-term future, economically, socially and environmentally.

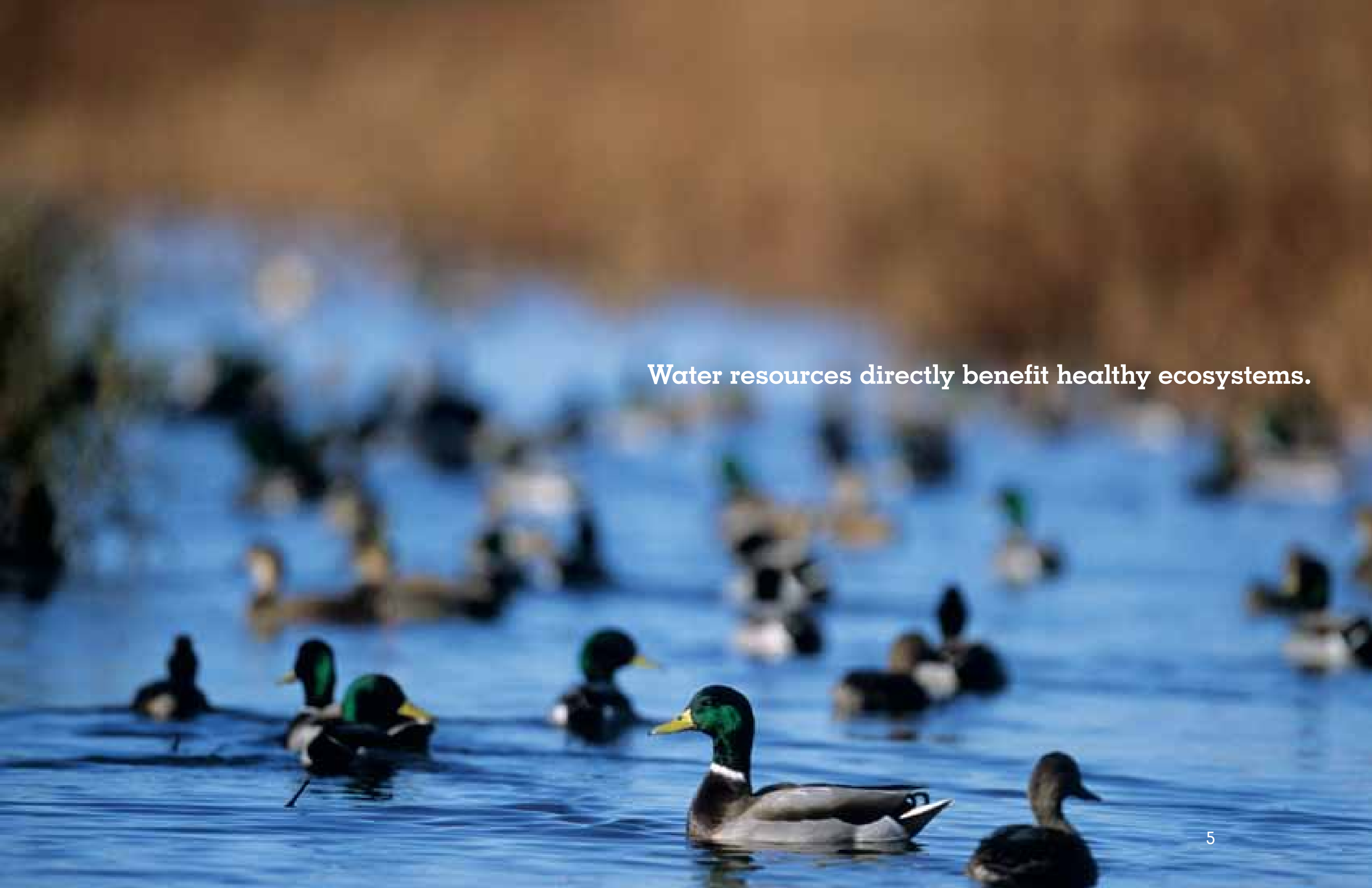
Surface Water Management

Water collected on the ground or in a river, stream, lake or wetland is referred to as surface water. Naturally replenished by precipitation, surface water is depleted by evaporation or seepage into the ground.

The Sacramento River and its tributaries are the main surface water supply sources for much of California's urban, agricultural and environmental areas, including areas north and south of the Bay-Delta. The unimpaired flow from the Sacramento River Hydrologic Region measured at the city of Sacramento averages approximately 22 million acre-feet annually, representing nearly one-third of the state's total annual runoff and the largest component of inflow to the Bay-Delta.

While the opportunities to increase outflow from the Valley are modest, increased water use efficiency provides many opportunities to restore and enhance our environment.

The region's water supply is delivered through a complex system of interconnected natural and constructed conveyance systems. Thousands of miles of well-maintained irrigation canals and drains interlace the Valley, providing surface water supplies to thousands of customers.



Water resources directly benefit healthy ecosystems.

Over 90 irrigation water suppliers (which include local public agencies and private companies) own, operate and maintain these systems to deliver water and provide drainage services to wetland managers and growers who cultivate a wide variety of permanent and annual crops.

Water Reuse Management

The Sacramento Valley is considered to be a "flow-through" system, which is due to the Valley's topography and geology and its current hydrologic state. The Sacramento River and its tributaries essentially act as drains while simultaneously serving as the prime water sources.

Much like a funnel, all of the water not consumed by crops and other vegetation or for other purposes will eventually return to the river or will percolate to groundwater that recharges local aquifers. Additionally, outflow from one user or water district is often the supply source for the next user or district downstream.

Because of its flow-through nature, the only water "lost" from the Sacramento Valley is through consumption. Thus, the only means of producing more outflow from the Valley would be through reduction of consumptive uses.

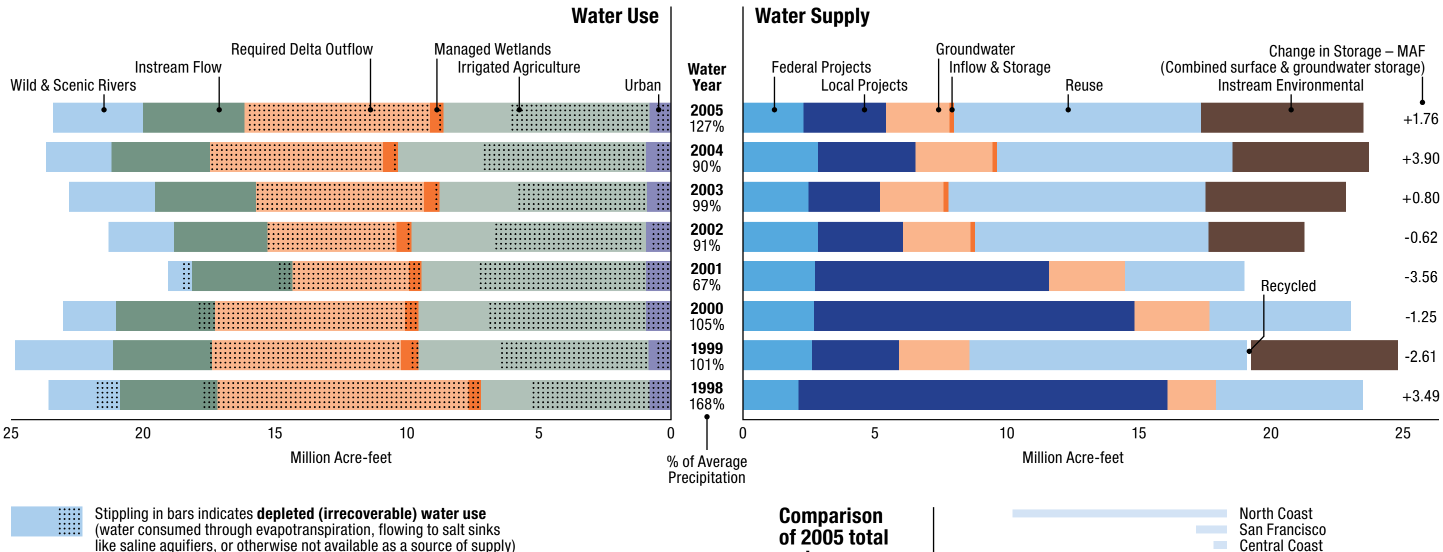
Effectively managing the system flow requires that water resource managers carefully and effectively integrate water management practices such as conservation, measurement, reuse, and surface and groundwater use together so the location, timing, rate, and quality of flow can be optimized to achieve specific benefits, while not causing unintended impacts.

Refuge Water Management

In addition to being a highly productive farming region, the Sacramento Valley lies near the southern end of the Pacific Flyway migratory route and is one of the most prominent wintering sites for migratory waterfowl.

The Valley's seasonal marshes and winter-flooded rice fields attract nearly half of the waterfowl using the Pacific Flyway and hundreds of thousands of shorebirds, herons, egrets and ibis, among other species.

Sacramento River Hydrologic Region Water Balance Summary, 1998-2005



From the California Department of Water Resources, California Water Plan Bulletin 160-2009 (page SR-16). (This table was not generated as part of the report).

Make Every Drop Count – Protecting Our Most Valuable Resource.

After in-stream uses, farming and refuge water are the major uses of water in the Sacramento Valley (see table p. 7). Each year, about 5.5 million acre feet (maf) are diverted from Sacramento Valley rivers and tributaries for irrigation within the Valley, with an additional 2.5 maf pumped from Valley aquifers. To ensure efficiency and a viable farming community, water must be delivered to promote three goals:

- **Sufficiency** – To meet irrigation water requirements,
- **Efficiency** – To match the requirements of on-farm irrigation systems,
- **Affordability** – To maximize the potential for financially sustainable farms.

Agricultural Water Management

At the Farm and Refuge Level

Although most farmers in the Sacramento Valley rely on surface water, the surface supply in some areas may be supplemented with groundwater pumped from privately owned wells.

Irrigation districts or water companies deliver most of the surface water to fields and farms within the Sacramento Valley. In some areas, landowners are completely reliant upon groundwater.

Water directly benefits the Sacramento Valley's highly productive agriculture enterprises, which support the region's economy and communities; the healthy ecosystems that support a host of critical plant and animal species; and recreational opportunities used by people within and outside the Valley.

At the District Level

As water flows through the system, across boundaries, many districts operate recirculation systems that collect some or all of the drainwater from fields as well as operational spills from the district's supply canals and laterals. In these systems, the drainwater, which may include runoff from surface water deliveries and groundwater pumping, is lifted into the district's supply canals and is an integral part of the water supply available to fields and farms within the district.

Since the early 1990s, districts have been implementing programs within the Valley to protect anadromous fish species, including salmon and steelhead. As a result, today, most surface diversion facilities are equipped with state-of-the-art fish screens that assure water deliveries and protect salmon and other fish species.

Sacramento Valley water resource managers have one overarching goal: sustainability. The Valley's water resources need to be managed to ensure that existing economic, social, and environmental systems endure indefinitely.

At the Basin Level

Water users cooperate to manage water discharge and reuse across jurisdictional lines. In most basins (and sub-basins) within the Valley, water reuse from one district to the next is "automatic," meaning that the system design allows for reuse to occur with no overt management or control asserted over the water.

Crop Water Management

Rice Water Management

Rice is a dominant crop grown in the Sacramento Valley, planted on about 525,000 acres and spanning a distance of some 120 miles – roughly Red Bluff to Sacramento. From a water management perspective, rice is different from other crops because it is grown under flooded conditions, which offers both crop production and environmental benefits.

Flooding helps to control certain competitive weeds and enhances the availability of nutrients. Additionally, ponded water acts as a thermal buffer, gaining heat during the day and releasing it at night to protect against cool nighttime temperatures that can reduce rice yield at certain growth stages.

The Environmental Benefits of Rice Cultivation

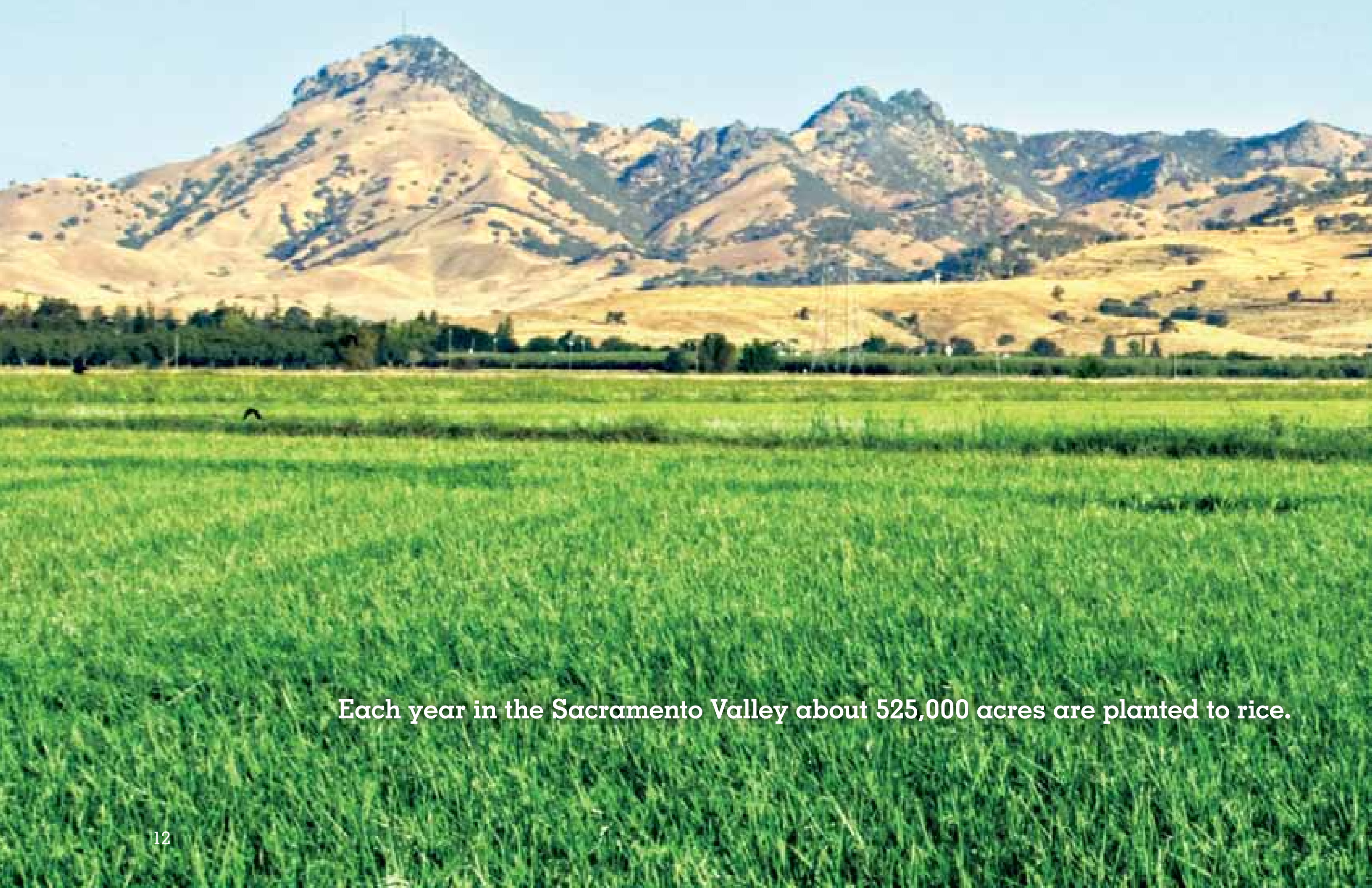
Over the past 30 years, the environmental benefits of rice cultivation have become better understood and documented, especially as they relate to habitat value for wintering waterfowl.

Of the 525,000 acres planted to rice each year in the Sacramento Valley, about 350,000 acres are re-flooded following harvest, with most fields maintained in a ponded state throughout the winter by precipitation and supplemental water application.

Six national and 50 state refuges/wildlife areas are the cornerstone for more than 75,000 acres of wetlands and associated uplands.

This is a double benefit. For the farmer, flooding helps in the decomposition of the rice straw, which otherwise would require burning or baling and removal. The flooding also creates favorable conditions for waterfowl. Eliminating burning of the rice straw also reduces harmful emissions to the atmosphere.

- Ricelands provide about 60 percent of all the food that wintering waterfowl consume in the Sacramento Valley each year.
- Every three acres of ricelands is equivalent to about two acres of wetlands. That's a good return on investment.
- Additionally, rice tailwater from the winter flood-up supplies 57 percent of water supplied to the area's 75,000 acres of wetlands.
- Ricelands support nearly 230 wildlife species, which include 187 birds, 27 mammals, and 15 reptile species. Of these, 30 are considered special-status species that rely upon ricelands for central habitat.



Each year in the Sacramento Valley about 525,000 acres are planted to rice.

Other Crops

Trees and row crops are planted to more than a million acres in the Sacramento Valley. Over the past few decades, farmers have made considerable progress in converting cropland and crops to water-efficient drip irrigation and micro-sprinklers for tree and row crops. Using micro-sprinklers to apply water to orchards is often more efficient and uses less water than other application methods. In fact, this method of application is proven to increase yields, enhance quality and achieve higher productivity with less water than conventional irrigation systems.

Water use efficiency in the Sacramento Valley must be defined within a framework that recognizes existing and possible future uses of water, and understands the physical characteristics of the hydrologic system, the interrelationships among water uses, and water management goals and objectives.

Row crops have benefited from advances in subsurface drip irrigation technology that allow liquid fertilizer to be mixed with irrigation water, providing water and nutrients directly to the plant roots.

Benefits of drip irrigation include:

- Increased fertilizer efficiency
- Better water quality protection
- Efficient water application
- Reduced need for field leveling
- Safe use of recycled water
- Optimal root zone moisture maintenance
- Minimal soil erosion
- Fewer weeds

Working Together – A Balanced Approach.

Sacramento Valley water resource managers are constantly striving for continuous improvement in managing resources. To do so effectively requires that they take into consideration three interrelated functions or components that work together to contribute to the well-being of the natural environment and the social well-being of those who live within and beyond the Valley's borders.

These components are:

1. **Ecological** – Environmental protection and stewardship
2. **Economic** – Financial considerations
3. **Social** – Society/community and individual human well-being

In general, a sustainable approach balances and maximizes benefits within the framework of these three components.

Depending on the area or issues at hand, focusing on only one of the three components is often at the expense of one or both of the others. Tradeoffs or unintended consequences are typically the result.

Whenever improvements to efficiency are made, water resource managers are fully aware of the tradeoffs and potential consequences of their management decisions. However, if we are to ensure that the Valley's water supplies are kept in balance for generations to come, it is critical that Valley water managers work together with local and State governments to develop working policies and conventions that embody regional sustainability and self-sufficiency principles.

Our rivers, streams, lakes, and reservoirs enhance the natural ecosystem by providing shelter for wildlife, as well as providing recreational and economic opportunities, and a sense of well being for the Sacramento Valley. These natural resources are a big part of what makes this such a unique and exceptional place to live. Sustaining these resources is essential to ensuring our long-term viability and a bright future for the Valley.

The Sacramento Valley is home to over 11,000 farms.

The Sacramento Valley provides a critical life source for most of California. Twenty five million people – two-thirds of California's population – depend on the Sacramento River for their water, so we need to make every drop count.

For more information on the Northern California Water Association and the *Efficient Water Management for Regional Sustainability in the Sacramento Valley Report*, please visit our website at **www.norcalwater.org**

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California Water Myths

Ellen Hanak • Jay Lund • Ariel Dinar
Brian Gray • Richard Howitt • Jeffrey Mount
Peter Moyle • Barton "Buzz" Thompson

with research support from Josue Medellin-Azuara, Davin Reed, Elizabeth Stryjewski, and Robyn Suddeth

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CALIFORNIA DEPARTMENT OF WATER RESOURCES

SUMMARY

California has a complex, highly interconnected, and decentralized water system. Although local operations draw on considerable expertise and analysis, broad public policy and planning discussions about water often involve a variety of misperceptions—or myths—about how the system works and the options available for improving its performance.

The prevalence of myth and folklore makes for lively rhetoric but hinders the development of effective policy and raises environmental and economic costs. Moving beyond myth toward a water policy based on facts and science is essential if California is to meet the multiple, sometimes competing, goals for sustainable management in the 21st century: satisfying agricultural, environmental, and urban demands for water supply and quality and ensuring adequate protection from floods.

We focus on eight common water myths, involving water supply, ecosystems, and the legal and political aspects of governing California's water system. These are not the only California water myths, but they are ones we find to be particularly distracting and disruptive to public policy discussions.

Often, myths serve the rhetorical purposes of particular stakeholders. And they persist because our public policy debates are not sufficiently grounded in solid technical and scientific information about how we use and manage water. In combating these myths, we hope to set the stage for a more rational and informed approach to water policy and management in the state.

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This report seeks to rebuild public policy discussions on myth-free foundations. Improving the collection, analysis, synthesis, and use of accurate information about the state's water system is also necessary to encouraging fact-based policies.

Of course, information alone will not dispel California's water myths. But better information can fashion more effective responses to California's many ongoing and future water challenges. In the months and years ahead, policymakers and voters will be involved in crucial decisions regarding one of California's most precious and controversial resources. Let's be sure those decisions are based on reality, not myth.

Myth	Reality
1. California is running out of water.	California has run out of abundant water and will need to adapt to increasing water scarcity.
2. [Insert villain here] is responsible for California's water problems.	There is no true villain in California water policy, but opportunities exist for all sectors to better use and manage water.
3. We can build our way out of California's water problems.	New infrastructure can contribute to California's water supply solutions, but it is not a cure-all.
4. We can conserve our way out of California's water problems.	Water conservation is important, but its effectiveness is often overstated.
5. Healthy aquatic ecosystems conflict with a healthy economy.	Healthy ecosystems provide significant value to the California economy, and many opportunities exist for mutually beneficial water management.
6. More water will lead to healthy fish populations.	Fish need more than water to thrive.
7. California's water rights laws impede reform and sustainable management.	The legal tools for reform are already present in California's water rights laws; we just need to start using them.
8. We can find a consensus that will keep all parties happy.	Tough tradeoffs mean that consensus is not achievable on all water issues; higher levels of government will need to assert leadership.

Please visit the report's publication page
http://www.ppic.org/main/publication.asp?i=890
to find related resources.

Myth 4: We Can Conserve Our Way Out of California's Water Problems

The Myth

The water conservation myth implies that California can adapt to changing conditions by focusing primarily on water use efficiency. Examples of countries such as Australia, where daily residential water use is reported to have fallen to roughly 40 gpcd during the recent drought (versus about 145 gpcd in California), are used to highlight the scope for savings (Whyte, 2009).[23] The danger with this myth lies in overestimating the real water savings achievable through conservation. Adherence to this myth distracts discussion from the need for more sweeping changes in water institutions, infrastructure, and management.

How the Myth Drives Debate

The idea that improvements in urban and agricultural water use efficiency could free up enough water for population growth and increased environmental use is appealing. It places blame for water problems on water users (Myth 2) while providing a silver bullet solution.

Environmentalists often promote conservation as an alternative to new infrastructure. After more than a decade of financial support to urban water utilities implementing conservations measures, a new law now requires reductions in per capita urban water use by 20 percent, in the expectation that this will free up significant supplies for other purposes.[24]

The Reality

Improvements in urban and agricultural water use efficiency have already helped California adapt to scarcity, and continued reductions in water use can help California cope with droughts and shortages (Myth 1). Reducing water withdrawals from streams and groundwater basins can yield environmental benefits, including improved streamflow, reduced pollution runoff into rivers, streams, and beaches (Noble et al., 2003), and reduced energy use for acquiring and treating water (California Energy Commission, 2005).[25]

But public policy discussions about water conservation often overestimate potential water savings by failing to distinguish between net and gross water use. Net (or "consumptive") water use refers to water consumed by people or plants, embodied in manufactured goods, evaporated, or discharged to saline waters. Once this water is used, it cannot be recaptured. Gross (or "applied") water use refers to water that runs through the taps of a home or business, or is applied to fields—not all of which is consumed. Some of it—known as "return flow"—is available for reuse, because it returns to streams and irrigation canals or recharges groundwater basins. Conservation measures often target reductions in gross water use. But because of return flow, net water savings are often lower (and never higher) than gross water savings. Only net water savings provide more water.

In agriculture, achieving significant net water savings generally requires switching to crops that consume less water or reducing irrigated land area; these two measures typically reduce farm profits and are therefore costly.26 By contrast, irrigation efficiency investments, which can increase farm profits, may reduce gross water use per acre but increase net water use on farms by making it easier for farmers to stretch their gross supplies across additional acres of cropland.[27]

Similar issues arise for urban water conservation. Outdoors, switching from thirsty lawns to plantings that use less water (a crop switch) can greatly reduce net water use. But reducing landscape overwatering (a reduction in gross water use) will generate net savings only if the excess water has not previously been recaptured in a stream or a groundwater basin.

Only net water savings provide more water

Opportunities for net savings from indoor water conservation depend on location. Almost all indoor water use returns to the system as treated wastewater. Thus, indoor conservation in coastal areas, which discharge wastewater to the sea, produces substantial net water savings. But indoor conservation in Sacramento—where wastewater discharges to the Sacramento River and can be reused by others before reaching the ocean—has little effect on California's net water use.

Not distinguishing between net and gross water savings in public discussions can create unrealistically high expectations for water conservation and inaccurate evaluations of the benefits of specific conservation measures. For instance, the large potential savings from urban conservation reported in the 2005 California Water Plan Update are gross, not net, savings (Department of Water Resources, 2005). The same is true for the governor's plan to reduce gross per capita urban water use 20 percent by 2020 (State Water Resources Control Board, 2009); although useful, the plan would produce significantly less than a 20 percent reduction in net urban water use.

BIGSTOCKPHOTO

Replacing lawns with landscapes that use less water generates net water savings but can be quite costly.

Public discussions also frequently fail to acknowledge that water conservation has implementation and operating costs, just like other actions (see the table). Some conservation quickly pays for itself—for example, low-flow fixtures that reduce hot water use save both energy and applied water (Gleick et al., 2003). But other actions can be quite costly, such as replacing lawns with landscapes that use less water (Hanak and Davis, 2006).

Replacing the Myth

Water conservation is important, but its effectiveness is often overstated.

To free up supplies for other users, conservation must focus on net water reductions. As with building new infrastructure, conservation should be part of a portfolio approach to water management, which is much more likely to be successful in addressing California's complex, locally varied, and evolving water problems (Jenkins et al., 2004).

Appendix C

Managing California's Water

From Conflict to Reconciliation

Ellen Hanak ▪ Jay Lund ▪ Ariel Dinar
Brian Gray ▪ Richard Howitt ▪ Jeffrey Mount
Peter Moyle ▪ Barton "Buzz" Thompson

Efficiency in Water Use

As discussed in Chapter 2, agricultural water use in California continues to become more efficient, primarily through increases in crop yields. Yields are likely to continue to progress in the decades to come.

Irrigation technology and management tools can help improve water quality, and this will become increasingly important as California works to reduce the flow of polluted agricultural runoff into streams and groundwater basins (Letey et al. in press). In areas prone to soil salinization, such as the west side of the San Joaquin Valley, reductions in drainage from irrigation efficiency improvements have already greatly reduced salt loads in local soils and receiving waters (Wichelns, Jouston, and Cone 1997; Wichelns and Cone 2006; Shoups et al. 2005).

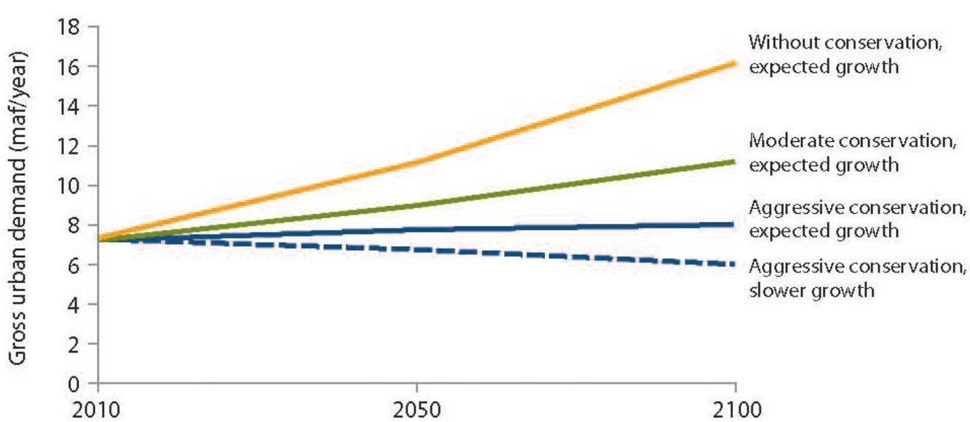
However, irrigation technology has less potential to create net water savings, because it generally does not reduce net agricultural water use (Box 2.1). Irrigation improvements can actually *increase* net water use by crops, by allowing either more intensive use of irrigation water on a given field (which raises both yields per acre and net water use per acre) or more extensive use of "saved" water on nearby fields that were previously less irrigated. Net water savings are more likely in areas where drainage water cannot be reused, such as where fields drain to brackish or saline aquifers or water bodies. Such savings have been the basis of water transfer agreements between the Imperial Irrigation District, whose crop runoff drains into the Salton Sea, and urban agencies in Southern California. Irrigation technology also can provide solutions to environmental water problems. But to create net water savings from farming in many parts of the state, reductions in crop acreage will be required. Some of this will happen naturally, as farmland is displaced by urban growth. Water marketing also provides an opportunity to compensate farmers and the local economy for reductions in acreage of low-value crops.

As in agriculture, improvements in urban water use efficiency can have water quality benefits. Inefficient landscape irrigation (generally less efficient than on-farm irrigation) is an important factor in polluted urban runoff. And even though the urban sector uses far less water than agriculture, urban water use efficiency actions—both indoors and outdoors—have a greater potential for net water savings. In the state's heavily populated coastal areas, most indoor water use savings result in net water savings, because most treated wastewater is discharged into the ocean. Improvements in outdoor water use efficiency, such as shifting from thirsty lawns to more drought-tolerant plants, can significantly reduce outdoor water use, especially in the hotter inland areas. Technological advancements in irrigation technology, including the use of "smart" irrigation control systems that use weather information to determine when plants need water, have the potential to significantly improve irrigation efficiency and reduce runoff from urban landscaping (Hanak and Davis 2006).

The introduction of more efficient indoor plumbing devices, such as low-flow toilets and showers, have already significantly reduced per capita urban use since the early 1990s (Chapter 2). Additional improvements in indoor plumbing (including more efficient appliances) as well as landscape planting changes, higher urban densities, and improvements in landscape irrigation have the potential to considerably slow growth in urban water use (California Department of Water Resources 2009; Gleick et al. 2003; Hanak and Davis 2006; CALFED 2006). With the mid-range population projections noted above at today's use rate (roughly 200 gallons per person per day [gpcd]), gross urban water demand would roughly double by the end of the century (Figure 3.8). A moderate conservation effort (20 percent by 2050 and 30 percent by 2100) would significantly lessen demand growth, and a more aggressive conservation effort (30 percent by 2050 and 40 percent by 2100) would keep gross urban demands roughly constant. These efforts would result in water use levels falling to 140–160 gpcd by 2050, and 100–140 gpcd by 2100. Lest this seem unreasonable, it is worth recalling that urban water use in the early 2000s in other developed economies with similar climates was 80–130 gpcd in Australia, 84 gpcd in Israel, and 76 gpcd in Spain (Food and Agricultural Organization of the United Nations, undated).[23] In Chapter 6, we explore the potential for aggressive urban conservation efforts to reduce pressures on the Delta and facilitate adaptation to climate change.

Figure 3.8

Successful conservation efforts could significantly slow urban water demand growth



NOTES: Expected population growth scenarios are from Sanstad et al. (2009): 59.2 million in 2050 and 85.3 million in 2100. Slower growth projections are 51.7 million and 64.6 million, respectively (unpublished estimates from Hans Johnson 2009). Moderate conservation assumes 20 percent reduction by 2050 (160 gpcd) and 30 percent by 2100 (140 gpcd). Aggressive conservation assumes 30 percent reduction by 2050 (140 gpcd) and 50 percent reduction by 2100 (100 gpcd).

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23. The low estimate for Australia is from www.nwc.gov.au/www/html/2765-national-performance-report-2008-09---urban-water-utilities.asp?intSiteID=1. Urban water use in Australia has been further reduced in recent years in response to prolonged drought.